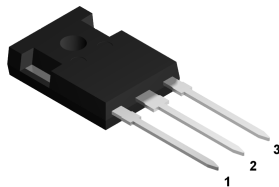
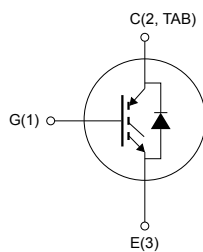


## Trench gate field-stop, 650 V, 40 A, high-speed HB2 series IGBT in a TO-247 long leads package



TO-247 long leads



NG1E3C2T



### Features

- Maximum junction temperature :  $T_J = 175\text{ °C}$
- Low  $V_{CE(sat)} = 1.55\text{ V (typ.) @ } I_C = 40\text{ A}$
- Co-packaged protection diode
- Minimized tail current
- Tight parameter distribution
- Low thermal resistance
- Positive  $V_{CE(sat)}$  temperature coefficient

### Applications

- Welding
- Power factor correction

### Description

The newest IGBT 650 V HB2 series represents an evolution of the advanced proprietary trench gate field-stop structure. The performance of the HB2 series is optimized in terms of conduction, thanks to a better  $V_{CE(sat)}$  behavior at low current values, as well as in terms of reduced switching energy. A diode used for protection purposes only is co-packaged in antiparallel with the IGBT. The result is a product specifically designed to maximize efficiency for a wide range of fast applications.

#### Product status link

[STGWA40HP65FB2](#)

#### Product summary

<b>Order code</b>	STGWA40HP65FB2
<b>Marking</b>	G40HP65FB2
<b>Package</b>	TO-247 long leads
<b>Packing</b>	Tube

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ V)	650	V
$I_C$	Continuous collector current at $T_C = 25$ °C	72	A
	Continuous collector current at $T_C = 100$ °C	45	A
$I_{CP}^{(1)}$	Pulsed collector current	120	A
$V_{GE}$	Gate-emitter voltage	±20	V
	Transient gate-emitter voltage ( $t_p \leq 10$ µs)	±30	
$I_F$	Continuous forward current at $T_C = 25$ °C	5	A
	Continuous forward current at $T_C = 100$ °C	5	
$I_{FP}^{(1)}$	Pulsed forward current	10	A
$P_{TOT}$	Total power dissipation at $T_C = 25$ °C	230	W
$T_{STG}$	Storage temperature range	-55 to 150	°C
$T_J$	Operating junction temperature range	-55 to 175	°C

1. Pulse width is limited by maximum junction temperature.

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case IGBT	0.65	°C/W
	Thermal resistance junction-case diode	5	
$R_{thJA}$	Thermal resistance junction-ambient	50	

## 2 Electrical characteristics

$T_C = 25\text{ °C}$  unless otherwise specified.

**Table 3. Static characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}$ , $I_C = 1\text{ mA}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$ , $I_C = 40\text{ A}$		1.55	2	V
		$V_{GE} = 15\text{ V}$ , $I_C = 40\text{ A}$ , $T_J = 125\text{ °C}$		1.75		
		$V_{GE} = 15\text{ V}$ , $I_C = 40\text{ A}$ , $T_J = 175\text{ °C}$		1.85		
$V_F$	Forward on-voltage	$I_F = 5\text{ A}$		2.6	3.5	V
		$I_F = 5\text{ A}$ , $T_J = 125\text{ °C}$		2.3		
		$I_F = 5\text{ A}$ , $T_J = 175\text{ °C}$		2.2		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$ , $I_C = 1\text{ mA}$	5	6	7	V
$I_{CES}$	Collector cut-off current	$V_{GE} = 0\text{ V}$ , $V_{CE} = 650\text{ V}$			25	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current	$V_{CE} = 0\text{ V}$ , $V_{GE} = \pm 20\text{ V}$			$\pm 250$	nA

**Table 4. Dynamic characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0\text{ V}$	-	2300	-	pF
$C_{oes}$	Output capacitance		-	122	-	
$C_{res}$	Reverse transfer capacitance		-	64	-	
$Q_g$	Total gate charge	$V_{CC} = 520\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 0$ to $15\text{ V}$ (see Figure 26. Gate charge test circuit)	-	153	-	nC
$Q_{ge}$	Gate-emitter charge		-	29	-	
$Q_{gc}$	Gate-collector charge		-	67	-	

**Table 5. Switching characteristics (inductive load)**

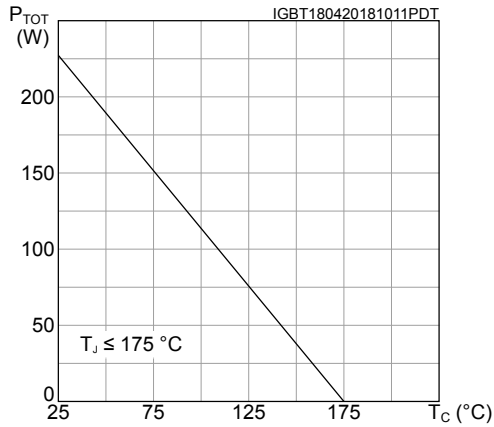
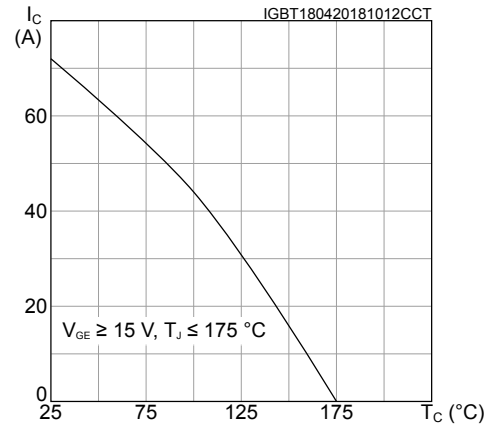
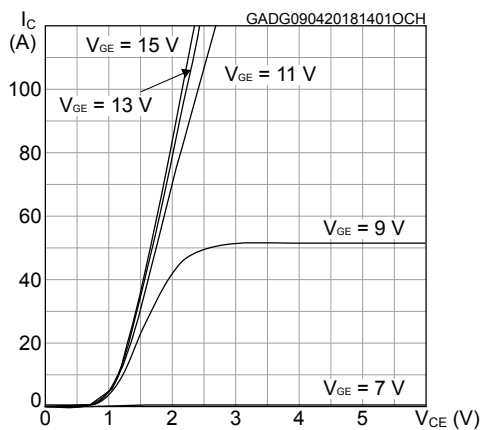
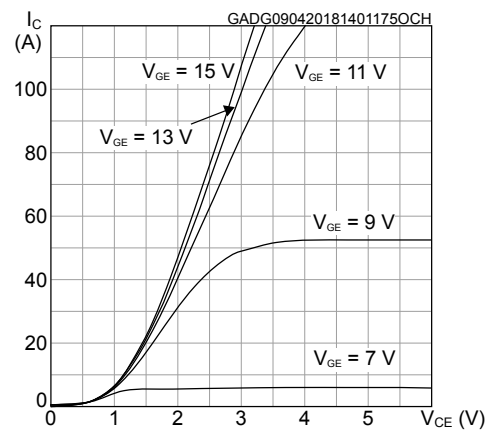
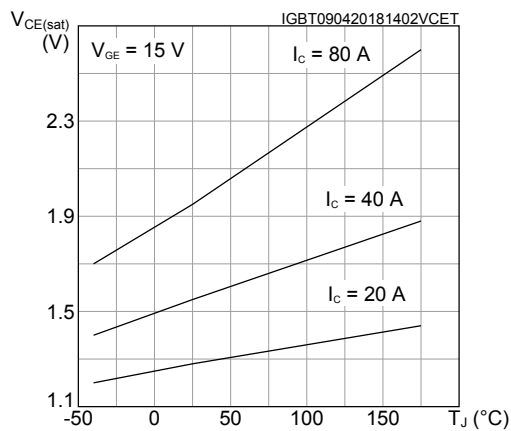
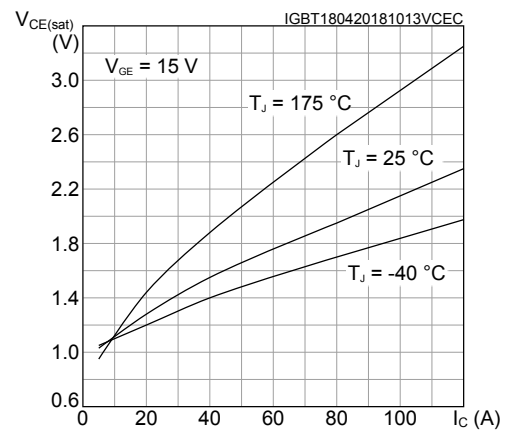
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 400\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 4.7\ \Omega$	-	125	-	ns
$t_f$	Current fall time		-	24	-	ns
$E_{off}^{(1)}$	Turn-off switching energy	(see Figure 25. Test circuit for inductive load switching)	-	410	-	$\mu\text{J}$
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 400\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 4.7\ \Omega$ , $T_J = 175\text{ °C}$	-	131	-	ns
$t_f$	Current fall time		-	58	-	ns
$E_{off}^{(1)}$	Turn-off switching energy		(see Figure 25. Test circuit for inductive load switching)	-	780	-

1. Including the tail of the collector current.

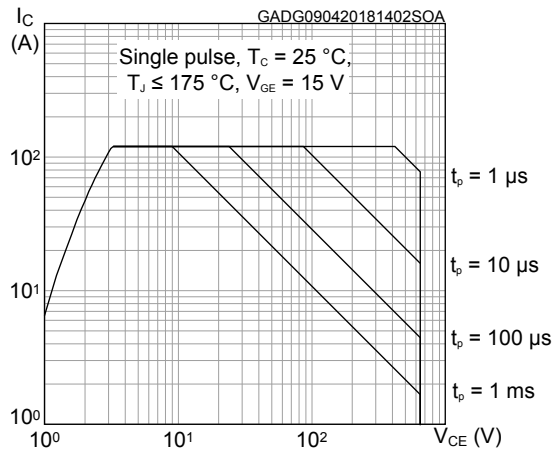
**Table 6. Diode switching characteristics (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{rr}$	Reverse recovery time	$I_F = 5\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$ (see Figure 28. Diode reverse recovery waveform)	-	140	-	ns
$Q_{rr}$	Reverse recovery charge		-	21	-	nC
$I_{rrm}$	Reverse recovery current		-	6.6	-	A
$di_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	430	-	A/ $\mu\text{s}$
$E_{rr}$	Reverse recovery energy		-	1.6	-	$\mu\text{J}$
$t_{rr}$	Reverse recovery time	$I_F = 5\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$ , $T_J = 175\text{ }^\circ\text{C}$ (see Figure 28. Diode reverse recovery waveform)	-	200	-	ns
$Q_{rr}$	Reverse recovery charge		-	47.3	-	nC
$I_{rrm}$	Reverse recovery current		-	9.6	-	A
$di_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	428	-	A/ $\mu\text{s}$
$E_{rr}$	Reverse recovery energy		-	3.2	-	$\mu\text{J}$

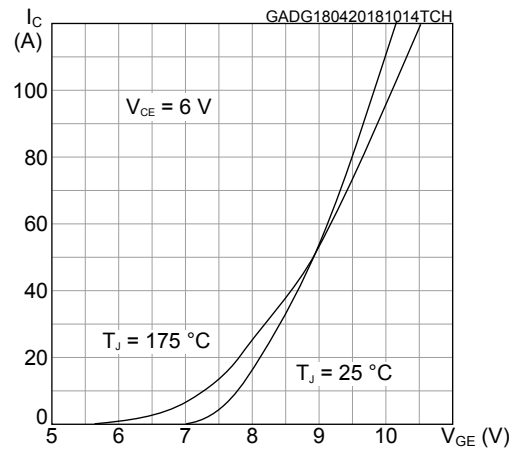
## 2.1 Electrical characteristics (curves)

**Figure 1. Power dissipation vs case temperature**

**Figure 2. Collector current vs case temperature**

**Figure 3. Output characteristics ( $T_J = 25 \text{ }^\circ\text{C}$ )**

**Figure 4. Output characteristics ( $T_J = 175 \text{ }^\circ\text{C}$ )**

**Figure 5.  $V_{CE(sat)}$  vs junction temperature**

**Figure 6.  $V_{CE(sat)}$  vs collector current**


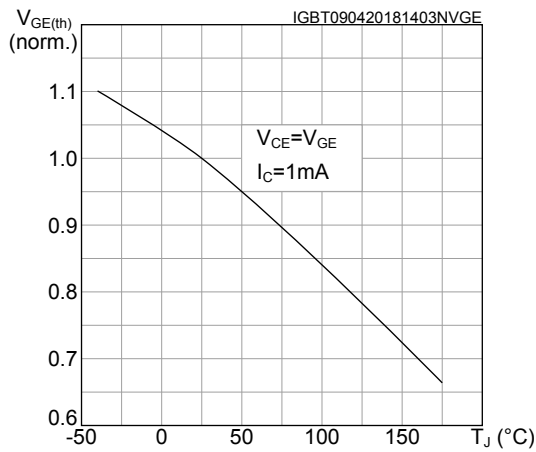
**Figure 7. Forward bias safe operating area**



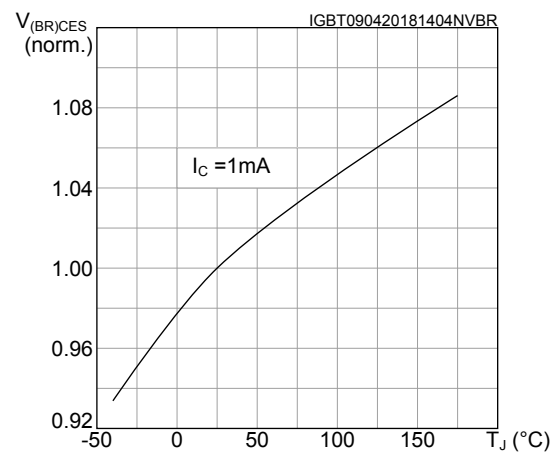
**Figure 8. Transfer characteristics**



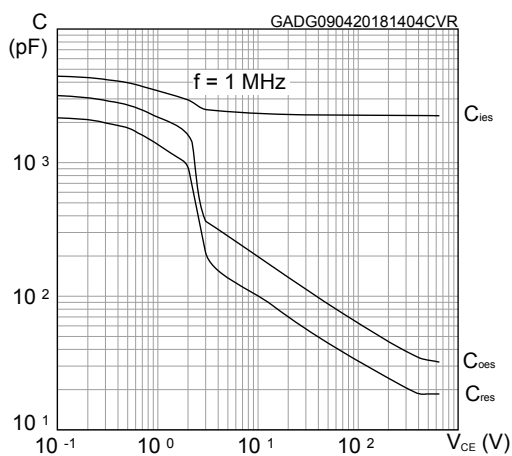
**Figure 9. Normalized  $V_{GE(th)}$  vs junction temperature**



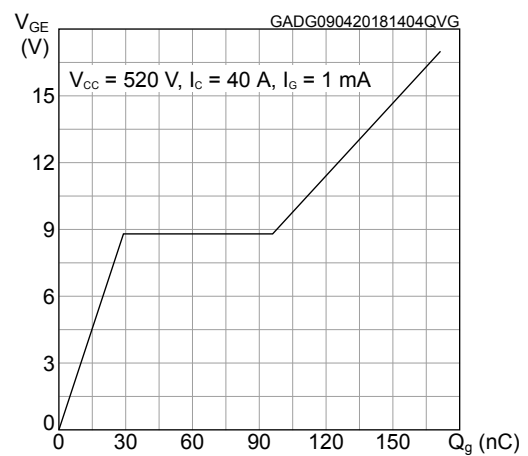
**Figure 10. Normalized  $V_{(BR)CES}$  vs junction temperature**



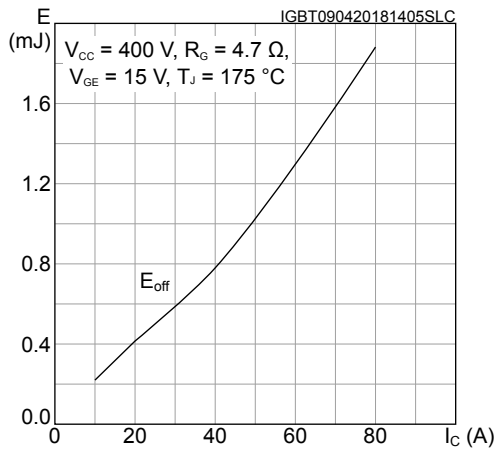
**Figure 11. Capacitance variations**



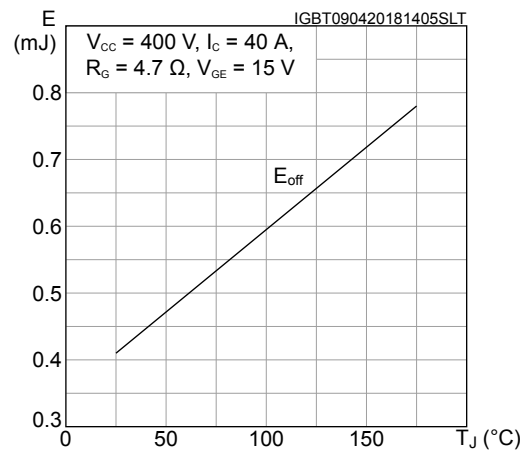
**Figure 12. Gate charge vs gate-emitter voltage**



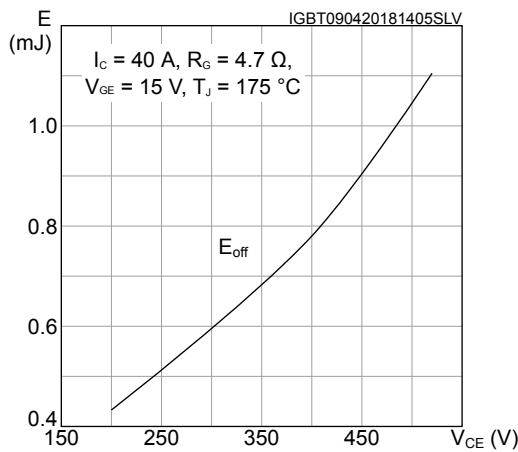
**Figure 13. Switching energy vs collector current**



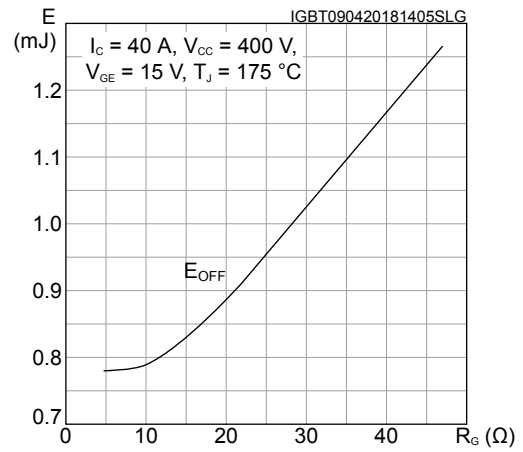
**Figure 14. Switching energy vs temperature**



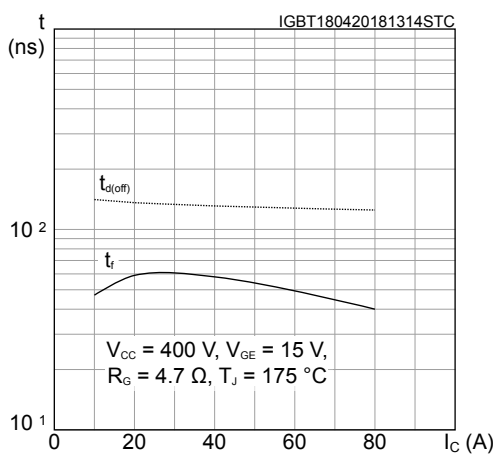
**Figure 15. Switching energy vs collector emitter voltage**



**Figure 16. Switching energy vs gate resistance**



**Figure 17. Switching times vs collector current**



**Figure 18. Switching times vs gate resistance**

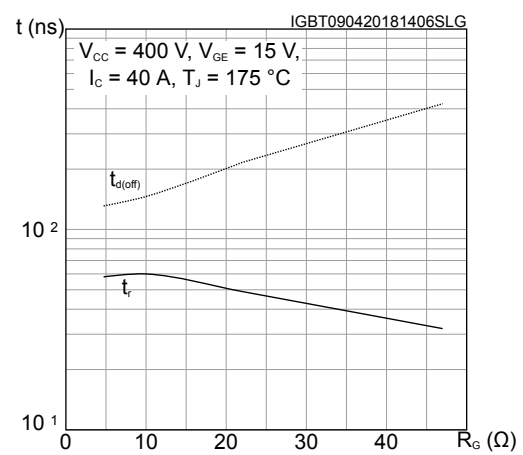


Figure 19. Reverse recovery current vs diode current slope

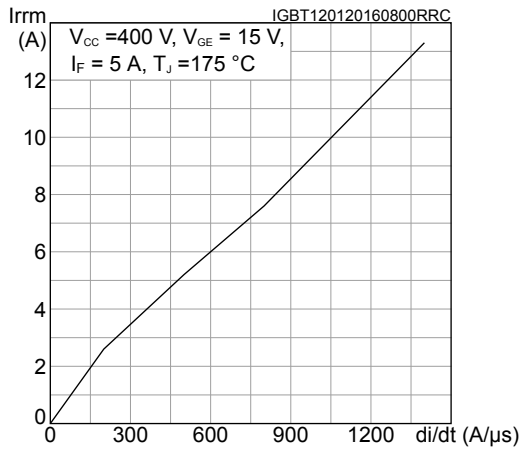


Figure 20. Reverse recovery time vs diode current slope

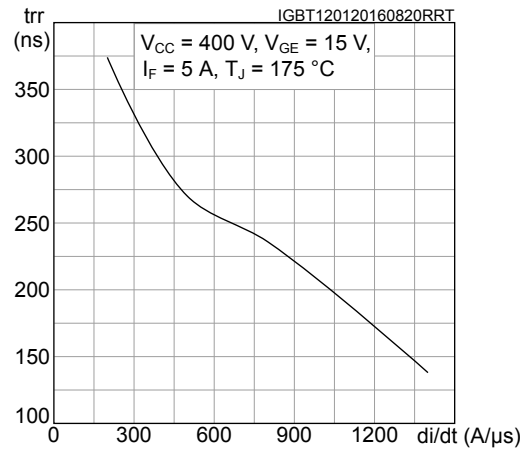


Figure 21. Reverse recovery charge vs diode current slope

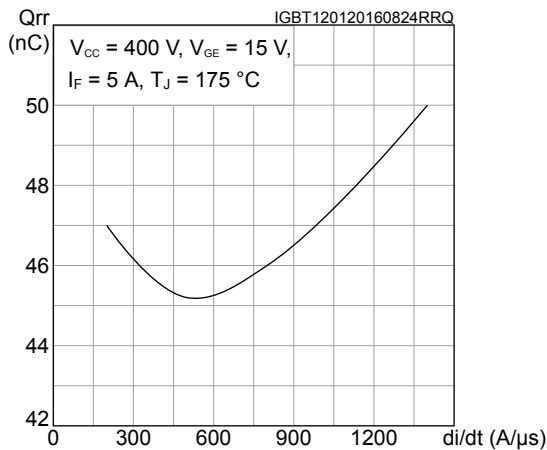


Figure 22. Reverse recovery energy vs diode current slope

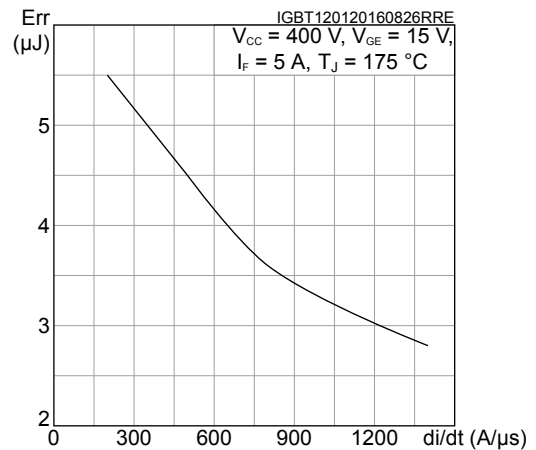


Figure 23. Thermal impedance for IGBT

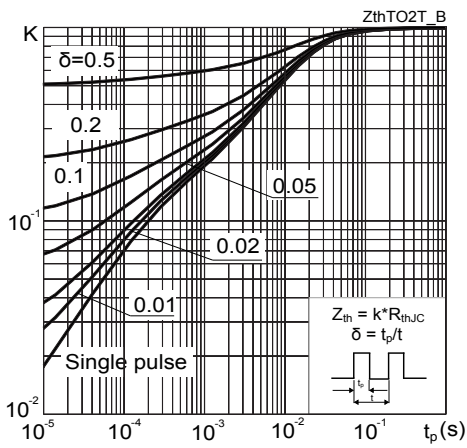
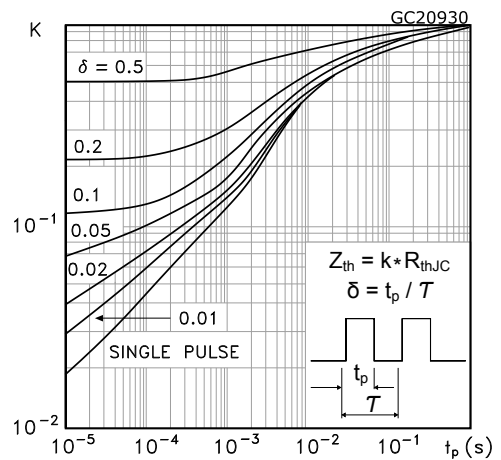
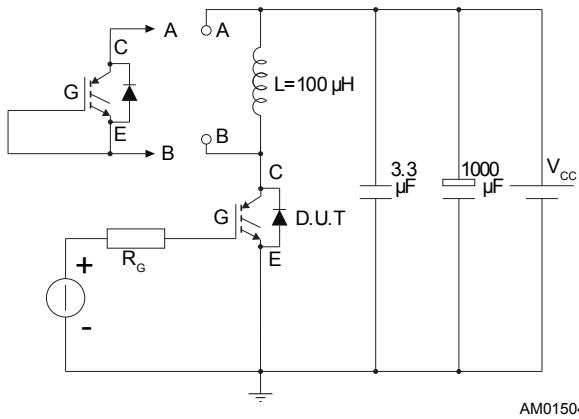
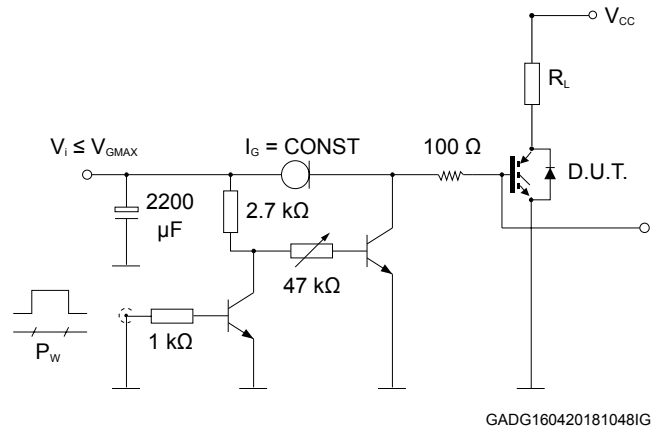
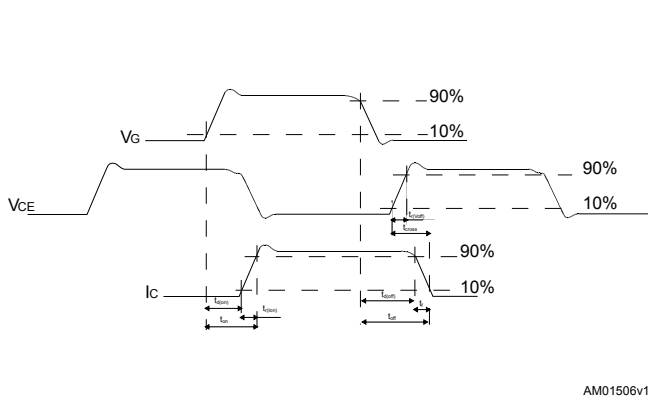
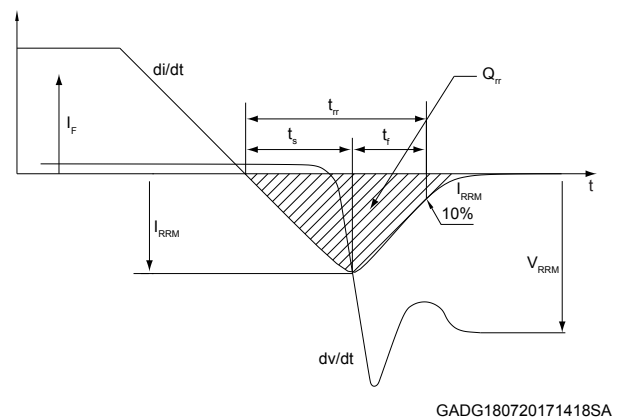


Figure 24. Thermal impedance for diode





### 3 Test circuits

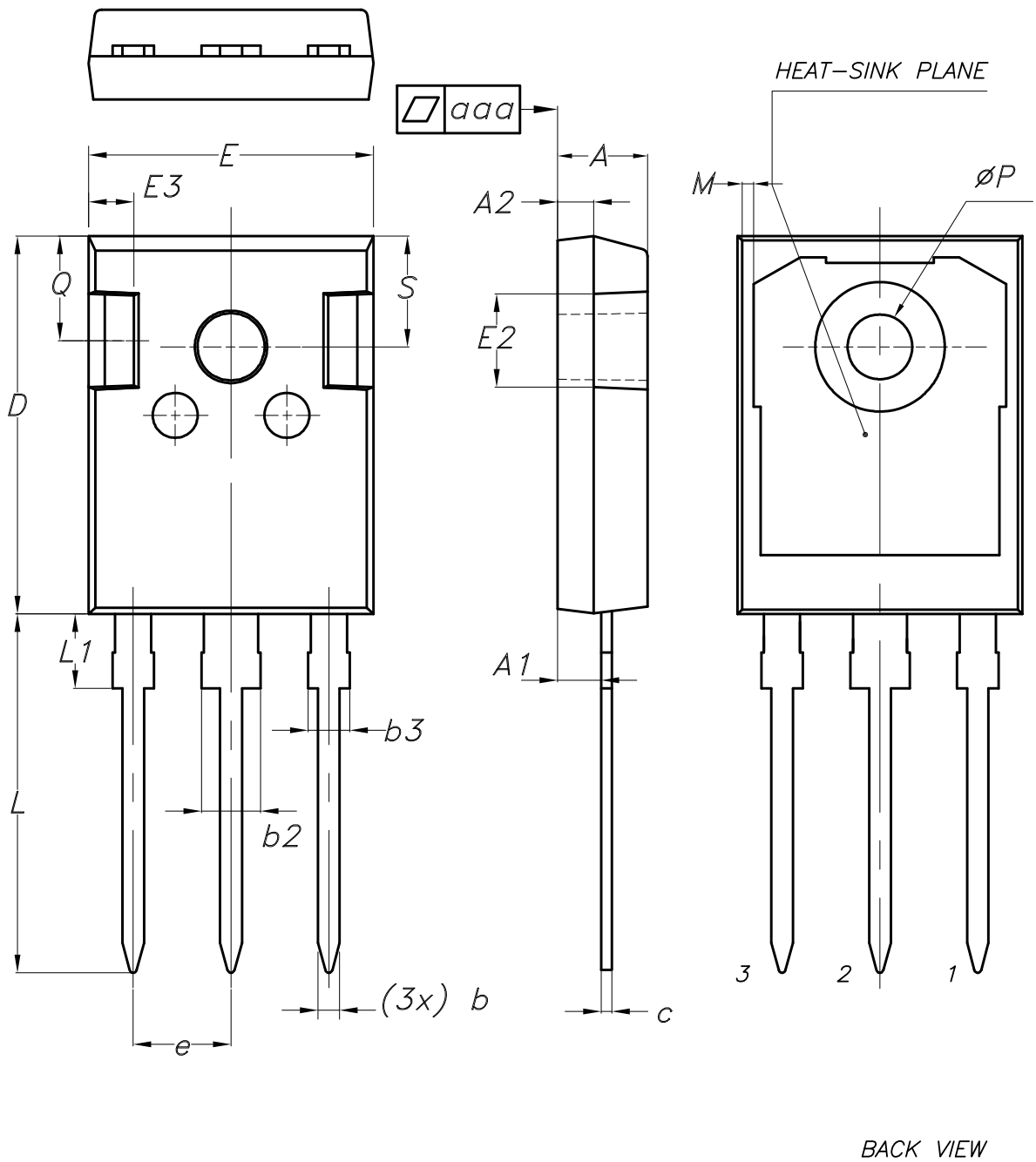
**Figure 25. Test circuit for inductive load switching**

**Figure 26. Gate charge test circuit**

**Figure 27. Switching waveform**

**Figure 28. Diode reverse recovery waveform**


## 4 Package information

To meet environmental requirements, ST offers these devices in different grades of **ECOPACK** packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions, and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

### 4.1 TO-247 long leads package information

Figure 29. TO-247 long leads package outline



BACK VIEW

8463846\_5

**Table 7. TO-247 long leads package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
b	1.16		1.26
b2			3.25
b3			2.25
c	0.59		0.66
D	20.90	21.00	21.10
E	15.70	15.80	15.90
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	5.34	5.44	5.54
L	19.80	19.92	20.10
L1			4.30
M	0.35		0.95
P	3.50	3.60	3.70
Q	5.60		6.00
S	6.05	6.15	6.25
aaa		0.04	0.10

## Revision history

**Table 8. Document revision history**

Date	Version	Changes
18-Apr-2018	1	Initial release. The document status is production data.
05-Jul-2018	2	Modified <i>Table Switching characteristics (inductive load)</i> . Modified <i>Figure Switching energy vs temperature</i> . Minor text changes.
24-Jul-2019	3	Updated <i>Table 1. Absolute maximum ratings</i> and <i>Table 2. Thermal data..</i> Minor text changes.
02-Oct-2024	4	Updated <i>Section 4.1: TO-247 long leads package information</i> . Minor text changes.
21-Nov-2024	5	Updated <a href="#">Table 3. Static characteristics</a> . Removed figure <i>Diode <math>V_F</math> vs forward current</i> .

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